Development and Experimental Evaluation of Oceanic Evaporation Duct Models Based on the LKB Approach

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LONG-TERM GOAL

Our long term goal is to contribute to the development and evaluation of an operational evaporation duct model for use in microwave propagation prediction.

OBJECTIVES

We have three main objectives. Our first objective is to develop a metric, involving one or more parameters, to replace evaporation duct height as a fundamental basis for comparison and evaluation of evaporation duct models. Our second objective is to use experimental data to evaluate various LKB-based (where LKB refers to Liu et al 1979) evaporation duct models (e.g., the BYC model described in Babin et al 1997, the NRL-Monterey Model, etc.) to determine the best model(s) using the objective criterion from the first objective. Our third objective is to perform a sensitivity study to evaluate the possible effects of issues raised during the Naval Postgraduate School Evaporation Duct Workshops on the LKB approach to evaporation duct models.

APPROACH

To accomplish the first objective, we are examining various statistical techniques to determine candidate parameters to describe vertical refractivity profiles for model evaluation. To accomplish the second objective, data collected during field experiments will be used to compare the candidate models. In particular, a field test conducted in November 1998 obtained one day of data from the Johns Hopkins University Applied Physics Laboratory (JHU/APL) profiling buoy that made continuous measurements between 8 and 83 cm above the sea surface. We are planning to coordinate with at least two additional opportunities to deploy this buoy during FY 2000. To accomplish the third objective, a sensitivity study will be performed addressing assumptions made by various LKB-based

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models (e.g., Fairall et al 1996), such as those discussed at the Naval Postgraduate School Evaporation Duct Workshops. For example, the effects of surface layer turbulence at low wind speeds will be examined in light of data from the FY 2000 field experiments.

WORK COMPLETED

Work on this project was not begun until near the end of FY 1999. Our work to date has been in three areas. One area is the writing of software that will read the profiling buoy data, organize it into individual profiles and plot the results. We are trying to make this software general enough to read future data collected from the JHU/APL profiling buoy. The second area is the determination of viable alternatives to simple duct height as a means of describing evaporation duct model outputs and making quantitative comparisons with measured refractivity profiles. For accurate propagation prediction, it is important for the evaporation duct model to produce accurate vertical slopes of refractivity. One idea being explored involves using a root-mean-square error between a model profile and a fine-scale measurement after removing the means from both profiles. Another idea under consideration is the use of a combination of duct height and mean slope below the duct. These approaches are being evaluated using data taken during field experiments. The third area is the planning and organization of field experiments in which the JHU/APL profiling buoy will be deployed from the R/V CHESSIE. This buoy provides the finest scale measurements yet available within the atmospheric surface layer. We will either have a single dedicated field experiment during the 1999-2000 winter season or conjoin deployment of the JHU/APL profiling buoy to at least two existing field experiments. The later scenario is preferred because it would enable the collection of more data over a wider variety of atmospheric conditions than a single one-week experiment and it would obtain more data per dollar cost. We are talking with NSWC-Dahlgren Division about having the R/V CHESSIE and JHU/APL profiling buoy deployment conjoined with the Y2K Wallops Microwave Propagation Measurement System (MPMS) Experiment being conducted in April 2000. We also expect to find at least one additional nearby field experiment occurring before April 2000 during which R/V CHESSIE and the JHU/APL profiling buoy could be deployed. Using both this new data (especially that collected during April 2000) and the data previously obtained in November 1998 will allow for some consideration of seasonal effects.

RESULTS

Because this project is just getting started, there are no results yet.

IMPACT/APPLICATION

This effort will result in several useful applications. Operations of radar and communications may be severely affected by refractive index gradients in the lower troposphere, especially over the ocean. For accurate microwave propagation prediction, there is a critical need for an evaporation duct model that provides realistic fine-scale vertical refractivity gradients using a minimum of surface layer measurements. Once such application would be using data from the MORIAH system for propagation prediction. Once reliable meteorological modeling has been achieved, simplifications can be made for operational purposes. The origin and magnitude of any errors resulting from these operational simplifications can then be determined. In addition, the resulting evaporation duct model may eventually be used with the near-surface grid point outputs of a mesoscale model such as the US Navy's

Coupled Ocean/Atmospheric Mesoscale Prediction System (COAMPS) to provide mesoscale refractivity forecasts.

TRANSITIONS

As mentioned under Impacts above, the results of this effort should lead to useful operational products for future use by the US Navy. For example, these products would provide a way of using data from the MORIAH system for propagation prediction of evaporation duct effects.

RELATED PROJECTS

None at this time.

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